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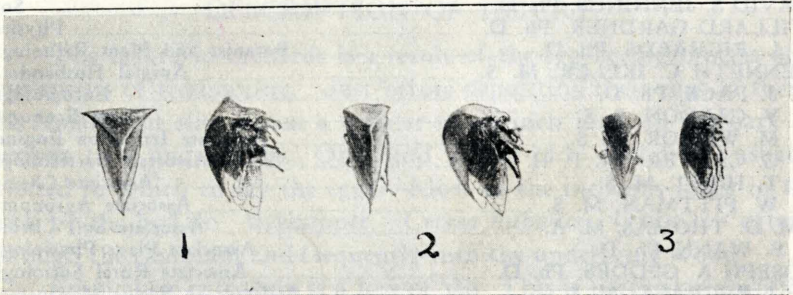
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Treehopper Injury in Utah Orchards

By

CHARLES J. SORENSON



Dorsal and side views of the following species of treehoppers:

1. *Ceresa bubalus* (Fabr.) (Buffalo treehopper)
2. *Stictocephala inermis* (Fabr.)
3. *Stictocephala gillettei* Godg. (x1½)

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Treehopper Injury in Utah Orchards

Charles J. Sorenson

INTRODUCTION

Treehopper injury is a problem that has given many fruit growers in Utah some concern during recent years. These people have observed that their young fruit trees and the twigs and smaller branches of older trees have been attacked during the autumn of each year in a manner that produced numerous cuts which later formed scars. The trees frequently became unthrifty, and more or less deformed and stunted, as a result of these annual attacks.

The investigation reported in this publication was made for the purpose of ascertaining the present status of the treehopper situation in Utah orchards.

DESCRIPTION OF INJURY

The injury in orchards is a result of the egg-laying process of a few species of treehoppers. Just before depositing their eggs in them, the females cut slits, about a quarter of an inch long, in the bark of various trees and shrubs. One- and 2-year-old wood is usually selected in which to lay the eggs. Most of the incisions made in the bark by the buffalo treehopper, *Ceresa bubalus* (Fabr.), extend through the cambium and frequently into the underlying wood.

From these cuts there is a loss of sap. This is particularly noticeable in young peach trees which have been attacked and quite evident in older peach trees. Apricot, cherry, and prune trees are infrequently attacked by treehoppers in Utah, but when they are, they "bleed" in much the same manner as peach trees. In apple and pear trees there is not the pronounced evidence of sap loss such as is characteristic of treehopper injury in trees of the stone fruits. Sap oozes from the treehopper wounds until the cut tissues have healed sufficiently to stop its flow.

The female buffalo treehopper, *C. bubalus*, usually, though not always, cuts her egg-pockets in pairs, the two slits of which are approximately parallel and about one-sixteenth to one-eighth of an inch apart. The incisions are made in such a way that the intervening bark usually dies. After two or three years the paired egg-pockets often appear as a single enlarged scar. Examples of treehopper injury in fruit trees are shown in Figures 1 and 2.



Fig. 1. Pear twigs showing typical injury caused by treehoppers. Egg-pockets and scars.

DISTRIBUTION OF INJURY

In a general survey, including most of the orchard districts of the state, from Lewiston in the northern part to St. George in the extreme southern part, and from Vernal on the east to Delta on the west, treehoppers or fruit trees injured by them were found. In Salt Lake,

Davis, Utah, Weber, Boxelder, and Washington Counties, which include the principal and oldest orchard districts of the state, treehoppers occurred in greatest abundance. In Millard County and in the Uintah Basin very few of these insects or their egg-pockets were observed.

In orchards where alfalfa, sweet clover, or weeds had been allowed to grow between the trees, treehopper injury was found almost without exception. These plants provide treehoppers with choice food, and the fruit trees afford favorable places for the insects to lay their eggs.

INJURY IN YOUNG ORCHARDS

Occasionally growers plant young fruit trees on alfalfa ground in which a few furrows have been plowed for each row of trees and the alfalfa between the rows is left for hay. In districts where treehoppers are numerous this practice usually results in serious injury to young trees. During this study, a number of examples of this method of planting, together with the results of such practice, have been observed.

CASE I.—In this case pear trees were planted in a 10-acre field of alfalfa. In the autumns of the three succeeding years these trees were cut excessively by ovipositing treehoppers. During this time the trees made but little more growth than they should have made in one year under favorable orchard conditions. At the end of three years the alfalfa was plowed up, and the orchard was clean-cultivated during the next two years. The trees made much better growth during the latter period, but the injurious effects produced in the first three years were far from outgrown.

CASE II.—Part of an apple orchard was planted in an alfalfa patch where a back-furrow had been plowed for each row of trees. The remainder of the orchard was planted on an adjacent piece of land which was clean-cultivated during the three succeeding seasons, and planted with corn the fourth season.

The soil in both portions of this orchard was apparently uniform. The trees were irrigated through furrows and the alfalfa was irrigated by the corrugation method.

The trees which grew in the alfalfa patch were attacked each autumn by numerous treehoppers, whereas the trees on the cultivated ground showed practically no evidence of attack. At the end of four years the trees which had been attacked annually were not more than one-half the size of the trees growing on the cultivated ground.

CASE III.—In the spring of 1923 a peach orchard was planted in plowed furrows in an alfalfa field on Provo Bench. After three successive years of severe treehopper attacks, together with some neglect, the orchard was practically worthless. Many of the trees were dead and most of the remainder were dying.

CASE IV.—Another example, which was especially observed during this investigation, was that of a newly-planted mixed orchard, consisting of apple, peach, and pear trees, located in the east Orem district of Utah County. The land had been broken up from alfalfa just before the trees were planted. During each of the four seasons that the orchard was under observation, volunteer alfalfa and weeds were permitted to grow between the trees. Numerous treehoppers attacked the trees during each autumn. Egg-pockets were cut almost as close as they could be in the bark.



Fig. 2. A 6-months-old peach tree "bleeding" as a result of treehopper injury.

In August and September of the first year the young peach trees were found "bleeding" rather profusely through these cuts. Particularly in young peach trees the sap oozes out through the treehopper wounds, and upon coming in contact with the air, hardens into the characteristic white "peach-gum". This sometimes may be seen sticking out of the wounds in curled and twisted strands about a sixteenth of an inch in diameter and from a fourth of an inch to an inch or more in length (Fig. 2). During a rainstorm these strands of gum become dissolved and the solution flows to the ground.

At the end of the 4-year period the trees were only about one-half the size of

normal trees of the same age.

In all four cases which have been mentioned, the fruit trees were severely cut during the fall of each year by ovipositing treehoppers. All of the trees thus attacked were covered, to a greater or lesser extent, with cuts and scars and became unthrifty, gnarled, and considerably dwarfed.

CASE V.—A fifth young orchard observed during this investigation was a 3-year-old pear orchard located on the Provo Bench. This orchard had been clean-cultivated from the time the trees were planted. The soil of the orchard was apparently uniform, and the trees had received approximately the same irrigation. Along one side of the orchard there was an irrigation ditch, the banks of which were overgrown with alfalfa. The distance between the alfalfa border and the first row of trees was about three feet, and this intervening strip was kept clean-cultivated along with the rest of the orchard. During the spring and summer months treehoppers gathered and fed in the alfalfa, and then in the early autumn of each year these insects moved on to the trees to lay their eggs. The trees in the outside row, and nearest to the alfalfa border, became extensively cut by the ovipositing treehoppers. The trees in the next, or second, row were only slightly attacked and those farther away from the alfalfa border showed practically no injury.

As a result of the conditions which influenced their growth, the trees in the outside row were noticeably smaller than those in the second row. The major difference in the environment of the trees in the two rows seemed to be that of treehopper injury.

If there was any border effect on the trees in the outside row it was only slight, for the 3-foot, clean-cultivated strip between this row and the ditchbank would provide an ample feeding area on the one side for 3-year-old pear trees. Furthermore, the ditch was comparatively shallow and carried water only when the orchard was irrigated.

Table 1 indicates the measurements of the trees in each row. The diameter was taken one foot above the surface of the ground.

INJURY IN OLD ORCHARDS

When alfalfa, sweet clover, or weeds grow between the trees in old orchards, the 1- and 2-year-old wood is usually cut severely by treehoppers. Trees which are more than six or eight years of age seem to outgrow most of the injurious effects of the treehopper wounds; yet in cases of heavy infestation the young wood of these older trees is frequently cut so extensively that there is undoubtedly

Table 1. Measurements of 3-year-old pear trees showing probable retardation of growth resulting from treehopper injury.

(Row 1 badly injured; row 2 slightly injured) *

Row 1			Row 2		
Tree No.	Height (Inches)	Diameter (Inches)	Tree No.	Height (Inches)	Diameter (Inches)
1	78	4.00	1	90	4.50
2	96	4.25	2	100	5.25
3	101	4.25	3	110	5.75
4	111	4.75	4	106	5.75
5	57	3.50	5	84	4.25
6	102	5.00	6	92	5.00
7	70	4.00	7	111	5.75
8	99	5.25	8	101	6.25
9	93	4.50	9	125	6.25
10	64	3.50	10	111	6.00
11	56	3.75	11	125	6.50
12	100	4.50	12	134	6.00
13	102	5.50	13	115	6.25
14	86	5.50	14	101	5.50
15	89	5.50	15	112	5.75
16	80	5.25	16	134	6.75
17	80	4.50	17	89	5.25
18	77	4.50	18	117	6.00
19	55	3.50	19	129	6.50
20	60	3.75	20	135	6.75
21	55	3.25	21	129	6.00
22	70	4.25	22	132	6.75
23	70	3.75	23	125	6.00
24	58	3.50	24	106	5.75
Totals	1909.00	104.00		2713.00	140.50
Average	79.54	4.33		113.04	5.85

*The difference in the average height of the trees in the two rows was 34.5 inches and the average diameter difference was 1.52 inches.

some hindrance to their normal growth and yielding capacity. Furthermore, the injured twigs become scarred, brittle, and weakened and are much more likely to break with the weight of the fruit.

In fruit trees of all ages the hopper wounds often provide places of lodgment and protection for other orchard insect pests such as woolly aphids and spider mites; these wounds may also serve as points of entry for some forms of disease-producing organisms or wood-boring insects. Furthermore, it becomes necessary for fruit trees that have been seriously cut to use a considerable amount of their food supply for the purpose of repairing the injured tissues.

SPECIES OF TREEHOPPERS COLLECTED IN UTAH ORCHARDS

With the exception of *Campylenchia latipes* (Say) and *Publilia modesta* Uhl., the species of treehoppers which have been collected in Utah orchards during this investigation are listed in Table 2; the

relative number of individuals of the various species is also indicated. *Campylenchia latipes* and *Publilia modesta* were found in considerable numbers in all localities visited. Neither of these species is known to feed or oviposit on fruit trees, nor is either species of economic consequence in the orchards of this state.

In a population of 788 treehoppers collected, 65 per cent was *Ceresa bubalus* (Fabr.), 31 per cent *Stictocephala gillettei* Godg., and the remaining 4 per cent consisted of *Stictocephala inermis* (Fabr.), *Ceresa basalis* Walk., and *Stictocephala pacifica* Van D.

GENERAL DESCRIPTION OF SPECIES

Ceresa bubalus (Fabr.), 1794, is commonly called the buffalo treehopper because in general appearance, with its large pronotum and horns, it is said to resemble a miniature buffalo. Living specimens of this species are grass-green in color; they range from 8 to 10 mm. in length and from 4 to 6 mm. in width between the tips of the horns. The horns are more prominent in this than in any other local species; they extend horizontally and laterally, and seldom if ever, do they curve posteriorly, and then only slightly.

Table 2. Treehopper species collected in Utah orchards*

	Locality from Which Collected	<i>Ceresa</i>			<i>Stictocephala</i>		
		<i>bubalus</i>	<i>basalis</i>	sp.?	<i>gillettei</i>	<i>inermis</i>	<i>pacifica</i>
1924							
8-7	Snow	181		2	1	8	
8-15	Elberta	18			3		
8-15	Mapelton	6			4		
8-17	St. George				8		
8-19	Price		6				
1926							
9-5	Logan	40	2			10	3
9-6	Brigham	38			44		
9-6	Willard	4			3		
9-6	North Ogden	22			6		
9-6	Ogden	1			10		
9-7	Clearfield	19			14		
9-8	Murray	10			2		
9-9	Payson	115			5		
9-9	Elberta	14			86		
9-12	Holden				4		
9-12	Nephi	9			6		
9-13	Provo Bench	28			46		
9-13	Duchesne	5					
9-17	Myton	2					
9-18	Lapoint	3					
	Totals	515	8	2	242	18	3
	Grand Total, 788						

*At Delta, Sutherland, Hinckley, in Daniels Canyon, the Strawberry Valley, and at Fruitland no trace of adult treehoppers or their egg-pockets was found in vegetation or on willows along streams and canals.

In the genera *Ceresa* and *Stictocephala* the anterior and dorsal portions of the body have a hard shell-like covering, formed from the pronotum, which is considerably enlarged at the anterior end and is projected posteriorly to a point near the tip of the abdomen in such a way as to give the body a triangular appearance when viewed from above. When at rest the wings of these insects are held in a roof-like position over the body (See cover cut).

The buffalo treehopper, *C. bubalus*, is responsible for most of the treehopper damage which occurs in Utah orchards. According to the literature reviewed in this study, the same species is credited with all similar damage in other sections of the United States.

Ceresa basalis Walk. is somewhat similar in general color and shape to *C. bubalus*. In *C. basalis*, however, the ventral surface of the body is black. This constitutes one of the principal characteristics which distinguishes it from other species of *Ceresa*.

The average length of specimens of *basalis* collected in Utah is 7 mm. and the average width between the tips of the horns is 4 mm. The horns in this species extend horizontally and laterally, very much the same as in *bubalus*.

C. basalis was collected only in small numbers at Price and at Logan.

Treehoppers of the genus *Stictocephala* are quite readily distinguished from those of the genus *Ceresa* by the absence of supra-humeral horns. Members of both genera are otherwise very similar in general form and color.

Stictocephala gillettei Godg. is green when first collected, though perhaps not quite so bright-colored as *C. bubalus*. *S. gillettei* is without horns and the pronotum is generally rotundate. This treehopper is the smallest of all the species which were observed to oviposit on fruit trees in Utah. Its average length is 7 mm., and the greatest width of the pronotum averages 3 mm. (See cover cut).

Stictocephala inermis (Fabr.) is a large, uniformly bright-green, hornless treehopper. The pronotum is distinctly angulate. *S. inermis* is considerably larger than *S. gillettei* and only slightly smaller than the average of *C. bubalus*. The average length of specimens of *S. inermis* is 9 mm. and the average width at the widest point of the pronotum is 4 mm. (See cover cut).

Stictocephala pacifica Van D. is very similar in color, shape, and size to *S. inermis*.

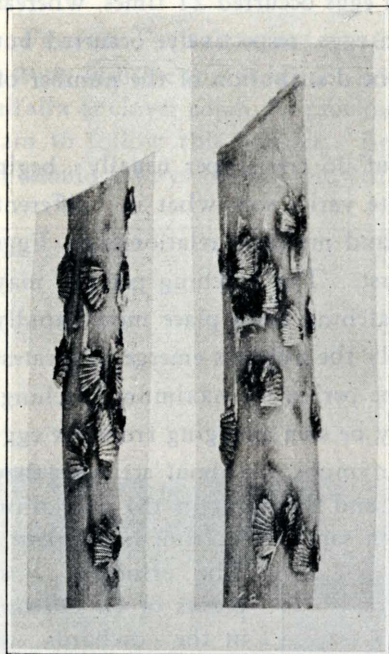
LIFE HISTORY STUDIES OF *CERESA BUBALUS* (Fabr.)

Fig. 3. One-year-old apple twigs from which the bark has been removed so as to expose treehopper eggs in natural position. (x $1\frac{1}{2}$)

The buffalo treehopper, *C. bubalus*, lays its eggs during August and September. In Utah orchards, this treehopper shows a preference for apple, pear, and peach trees; occasionally, its eggs are found in the bark of apricot, plum, prune, and cherry trees, in raspberry, currant, and gooseberry canes, and in poplar, cottonwood, soft maple, willow, and wild rose.

EGGS.—Freshly laid eggs are pearly white, elongate, and slightly curved, rounded at the base and gradually tapered toward the opposite end. Their average length is 1.5 mm., and at the point of greatest width, they average 0.4 mm. (Fig. 3).

Time Required for Oviposition—In observations which were made under natural conditions in the orchard, the average time occupied by the female treehopper in cutting each egg-pocket was 9.5 minutes. The time expended in laying an egg ranged from 20 to 90 seconds, averaging 56.6 seconds. The time expended in preparing an egg-pocket and laying the eggs in it averaged 15.7 minutes for each pocket.

Marlatt (4) found that the time required for the insertion of each egg by *C. bubalus* was from one-half to two minutes, and that about 20 minutes was required for cutting the slit and filling it with eggs. He also found that six to twelve eggs were deposited in each slit and that a single female treehopper of this species deposits "in excess of 100 eggs and possibly 200".

Number of Eggs in Pockets—The number of eggs contained in 100 egg-pockets, selected at random, totaled 726, ranging from 2 to 14 and averaging 7.26 eggs per pocket.

Pockets containing six eggs occurred most frequently, i.e., 23 times in the 100; those having seven eggs occurred 21 times, whereas pockets containing two and fourteen eggs, respectively, occurred but once. Between these two extremes the distribution of the number of eggs in a pocket was quite uniform.

NYMPHS.—The eggs of the buffalo treehopper usually begin hatching in April; however, the date varies somewhat in different years, depending upon temperature and moisture relationships. Eggs on sunny sides of the trees hatch first. The hatching period may extend over three or four weeks; hatching takes place more rapidly during warm weather, and apparently the nymphs emerge in greatest numbers before midday. During the period of maximum hatching, myriads of nymphal treehoppers may be seen emerging from the egg-pockets. Almost immediately these nymphs run about actively; they soon drop to the ground, however, and disappear in the vegetation under the trees where they feed upon sap sucked from host plants.

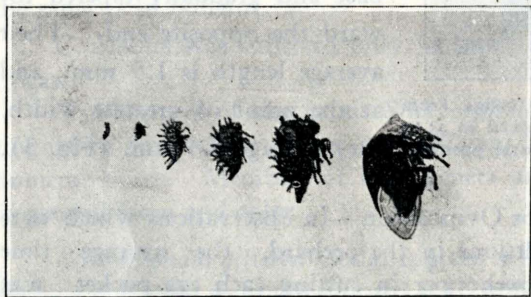


Fig. 4. Showing an individual egg, a nymph just hatched, and other stages of nymphal development to the full-grown buffalo treehopper. (x 1½)

The principal host plants of *C. bubalus* in the orchards of Utah are alfalfa, sweet clover, grasses, and various weeds. The young treehoppers keep rather well-hidden in the vegetation and are seldom seen until after transforming to the adult stage (Fig. 4).

ADULTS.—In Utah the adult stage is usually reached during July. The insects mate soon after reaching maturity and then the females move on to various trees and shrubs to oviposit. This usually begins early in August and continues into September or until freezing weather renders the insects inactive or kills them. There is but one generation of the buffalo treehopper each year. This species, and probably all other treehoppers in Utah, passes the winter in the egg stage.

CONTROL METHODS

PROPER PREPARATION OF GROUND.—The data obtained in this study indicate that it is poor practice to plant young fruit trees in an alfalfa or clover patch. As previously noted, serious injury is almost certain to follow this practice. Before planting a new orchard the land should always be well plowed and otherwise well prepared.

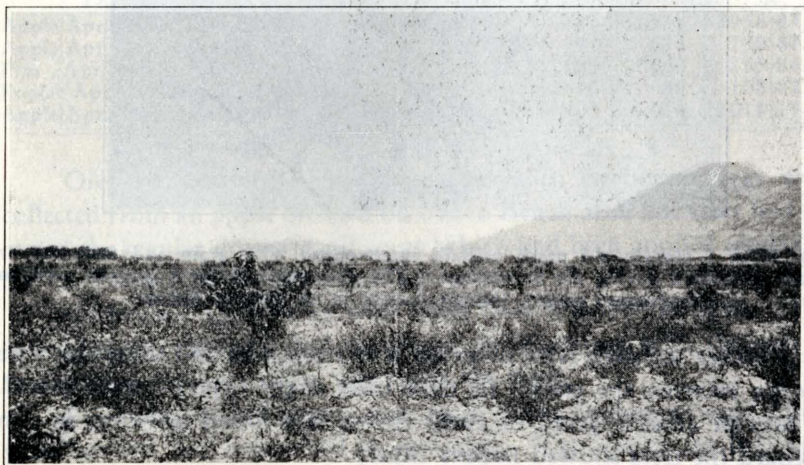


Fig. 5. A 6-months-old peach orchard with volunteer alfalfa and weeds growing between the trees. These trees had been severely cut by treehoppers.

CLEAN CULTIVATION.—Clean cultivation which eliminates from an orchard all alfalfa, sweet clover, and weeds during the growing season prevents treehopper injury. The 6-months-old peach orchard shown in Figure 5 was severely injured by treehoppers because volunteer alfalfa and weeds were permitted to grow among the trees. Figure 6 illustrates the thrifty growth made by young peach trees during the first season with clean cultivation. No trace of treehopper injury was observed in this orchard.

INTERCROPPING.—It is often desirable and advantageous to utilize the ground between the trees of a new orchard for growing other crops during the first three or four years, or until the size of the trees renders this practice infeasible. Several young orchards were observed during this study wherein strawberries, raspberries, squash, corn, oats, and wheat were grown between the trees with no treehopper injury. Apparently these plants are not attractive hosts to treehoppers.

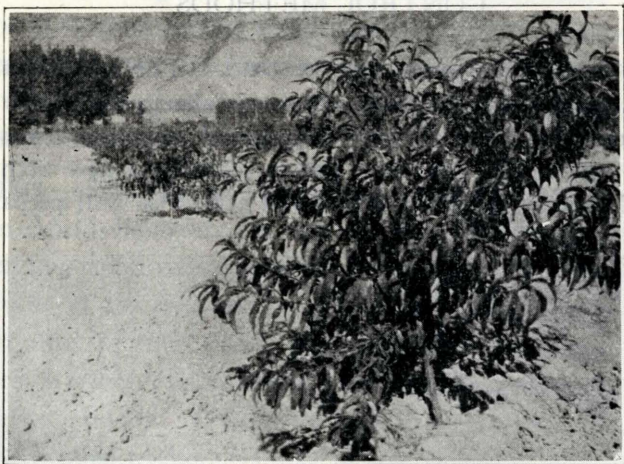


Fig. 6. A 6-months-old peach orchard intercropped with grain and followed by clean cultivation during the first season. The trees made excellent growth with no treehopper injury, though located in an infested district.

Other orchards were observed where potatoes and tomatoes were grown between the trees. In these cases slight injury was noted. Whenever alfalfa, grass, or sweet clover was found growing in an orchard the trees showed hopper injury.

PRUNING.—Early pruning of orchards eliminates many egg-infested twigs and branches, but it is impractical to prune out all infested wood without deforming or otherwise injuring the trees. The eggs in the bark of early pruned wood die when the bark dries out. Infested prunings taken out of the trees as late as April should be burned.

SPRAYING.—In older orchards where clean cultivation and intercropping are impractical and where it is desirable to grow alfalfa or sweet clover for their fertilizing value, some control of treehoppers may be secured by means of a dormant spray of miscible oil. As noted previously, treehopper injury is usually not of serious consequence in older orchards; for this reason a special application of an oil spray for the control of treehoppers probably would not be justified, except in special cases; yet, when the oil spray is to be used for the control of other orchard pests, such as the fruit-tree leaf-roller or San Jose scale, it has been found that a majority of the eggs of treehoppers is also killed. The ends of the eggs usually protrude somewhat into the open slits and are thus more or less exposed to the spray.

Laboratory Tests—Apple twigs heavily infested with the eggs of buffalo treehoppers were thoroughly sprayed in the laboratory. A few weeks later the eggs were examined to determine the number which had hatched and the number killed. These data are shown in Table 3.

Table 3. Results of laboratory spraying.

Variety	Date Sprayed 1926		Date Examined 1926	Eggs Hatched	Eggs Un-hatched	Total Eggs	Un-hatched %
Apple	Apr. 24	Ortho Kleenup Spray, 10%	May 13-15	382	2576	2958	87.09
Apple	Apr. 24	Dormant Soluble Oil, 10%	May 28	91	639	730	87.54
Pear	Apr. 24	Dormant Soluble Oil, 10%	May 30	105	660	765	86.28
Poplar	Apr. 24	Dormant Soluble Oil, 10%	May 15	19	89	108	82.32
Apple	Apr. 24	Unsprayed (check)	May 15-17	904	114	1018	11.20

Orchard Spraying—Twigs infested with treehopper eggs were collected from an apple orchard on Provo Bench after the trees had received the regular dormant-oil spray which had been applied especially for the control of the fruit-tree leaf-roller.

Unsprayed apple twigs were taken from a nearby orchard. The age of the two orchards and the degree of infestation with the eggs of treehoppers and leaf-rollers was about the same.

Examination and counts were made of the treehopper eggs which were hatched and unhatched in each case. The results are indicated in the following table:

Date Sprayed 1926		Date Examined	Eggs Hatched	Eggs Un-hatched	Total Eggs	Un-hatched %
Apr. 10	Ortho Kleenup, 10%	May 23-30	1172	2638	3810	69.30
	Unsprayed (check)	June 9	805	143	948	15.00

Comparing the results obtained in the laboratory tests with those secured in regular spraying practice in the orchard, it appears that thoroughness of application of the spray is a factor in determining the number of eggs killed. Where the same spray was used in both cases, there is a difference of 7.79 per cent in the results obtained. This may be accounted for, in part, by the fact that in spraying large trees it is difficult to get the outer twigs thoroughly covered with spray, and in these places the treehopper eggs are most numerous. It will be noted that in all of the eggs counted in the unsprayed twigs, both in the laboratory and field checks, 13.07 per cent did not hatch. This reduces just that much the percentage actually

killed by the oil spray. Even so, a dormant spray of miscible oil applied in ordinary orchard practice is effective in killing a majority of the treehopper eggs present.

Combination Calyx Spray—In orchards where the treehopper infestation is severe enough to justify the extra expense of adding nicotine sulfate to the regular calyx spray of lead arsenate, at least partial control would be obtained, because treehopper eggs are usually hatching when the calyx spray is applied and large numbers of the young insects would be killed by the nicotine in the combination spray.

After the treehopper nymphs have dropped to the ground and have obtained the protection of the vegetation, it would be difficult to kill them by spraying the vegetation under the trees.

PARASITISM—In Utah the eggs of the buffalo treehopper, *Ceresa bubalus*, are parasitized by the small hymenopterous parasite, *Polynema striaticorne* Gir. During the present study, this parasite has been obtained from eggs occurring in the twigs of apple, pear, peach, and poplar trees. A population of 8156 newly-hatched treehoppers and parasites emerged in the laboratory; of these 7660 were treehopper nymphs and 496, or 6.08 per cent, were *Polynema striaticorne*. This degree of parasitism is of minor importance in the control of treehoppers.

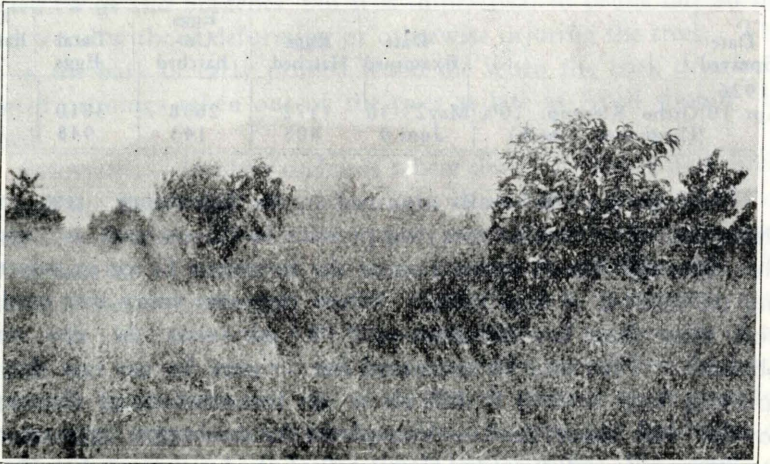


Fig. 7. A 7-year-old peach orchard overgrown with sweet clover and weeds. The trees have been severely injured by treehoppers. An example of orchard conditions particularly favorable to treehoppers.

SUMMARY

Treehopper injury in orchards is a result of cuts made in the bark of trees and shrubs by female treehoppers during oviposition.

A survey of the orchard districts in Utah showed that treehopper injury occurs, to a greater or lesser extent, in all of these districts and that this type of damage is most serious in orchards, particularly young ones, in which alfalfa, sweet clover, or weeds grow.

Under the latter conditions, young fruit trees are often seriously damaged. The trees suffer loss of sap, become scarred, deformed, and stunted and are made more susceptible to the attacks of some other insect pests and plant diseases.

The buffalo treehopper, *Ceresa bubalus* (Fabr.), is responsible for most of the treehopper damage in Utah. *Stictocephala gillettei* Godg. was found in approximately one-third the number of *C. bubalus*. Both of these species oviposit in the bark of fruit trees.

In addition to these two species, six other species of treehoppers were taken in orchards of the various districts. At the present time it appears that none of the latter species are of any economic importance in Utah.

Treehopper damage in orchards may be prevented by clean cultivation or by growing between the trees crops which do not serve as attractive food for treehoppers.

An important measure of control of treehoppers may be obtained with dormant miscible oil sprays such as are used in the control of the fruit-tree leaf-roller and San Jose scale, or when the treehopper infestation alone is serious enough to justify the expense of an oil spray.

Egg parasites are apparently of minor importance in the control of treehoppers in Utah.

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